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Our Case No. 9281-4288
Client Reference No. N US00130

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

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|---|---|
| In re Application of: | ) |
| Naoya Hasegawa et al. | ) |
| Serial No. To Be Assigned | ) |
| Filing Date: Herewith | ) |
| For: Exchange Coupled Film Having Improved Current-Carrying Reliability and Improved Rate of Change in Resistance and Magnetic Sensing Element Using Same | ) |

**PRELIMINARY AMENDMENT**

Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

Prior to examination of the above-identified application, please amend the application as follows:

**In the Specification**

Please rewrite the paragraph on page 62, lines 4-13 as follows:

(Amended) As shown in Fig. 3, an underlayer 6, a seed layer 22, a lower antiferromagnetic layer 4, a lower pinned magnetic layer 3, a lower nonmagnetic interlayer 2, and a free magnetic layer 1 are sequentially deposited in that order. The free magnetic layer 1 is constituted of three sublayers, namely, two Co sublayers 10 and a NiFe alloy sublayer 9. On the free magnetic layer 1, an upper nonmagnetic interlayer 52, an upper pinned magnetic layer 53, and an upper antiferromagnetic layer 54, and a protective layer 7 are sequentially deposited. The upper pinned magnetic layer 53 contains layers similar to that of the lower pinned magnetic layer 13. That is: an upper first magnetic sublayer 111, similar in composition and thickness to the first magnetic sublayer 11, an upper intermediate

sublayer 112, similar in composition and thickness to the intermediate magnetic sublayer 12, and an upper second magnetic sublayer 113, similar in composition and thickness to the second magnetic sublayer 13.

Please rewrite the paragraph on page 125, lines 12-21 as follows:

(Amended) As shown in Fig. 22, an underlayer 6, a seed layer 22, a lower antiferromagnetic layer 4, a lower pinned magnetic layer 3, a lower nonmagnetic interlayer 2, and a free magnetic layer 1 are sequentially deposited in that order. The free magnetic layer 1 is constituted of three sublayers, namely, two Co sublayers 10 and a NiFe alloy sublayer 9. On the free magnetic layer 1, an upper nonmagnetic interlayer 52, an upper pinned magnetic layer 53, and an upper antiferromagnetic layer 54, and a protective layer 7 are sequentially deposited. The upper pinned magnetic layer 53 has similar layers as that of the upper magnetic layer shown in Fig. 3.



**In the Claims**

Please rewrite Claim 1 as follows:

1. (Amended) An exchange coupled film comprising:

a nonmagnetic seed layer comprising $\alpha$ and Cr, $\alpha$ being at least one of Fe, Ni, and Co;

an antiferromagnetic layer; and

a ferromagnetic layer,

the seed layer, the antiferromagnetic layer, and the ferromagnetic layer being deposited in that order from the bottom, magnetization of the ferromagnetic layer being directed in a predetermined direction by an exchange coupling magnetic field produced at an interface between the antiferromagnetic layer and the ferromagnetic layer,

wherein a Cr content of the seed layer is 35 to 60 atomic percent, a thickness of the seed layer is 10 to 200 Å, and a crystal structure of the seed layer is a face-centered cubic structure.

Please rewrite Claim 6 as follows:

6. (Amended) An exchange coupled film according to Claim 1, wherein the thickness of the seed layer is at most 80 Å.

Please rewrite Claim 7 as follows:

7. (Amended) An exchange coupled film according to Claim 1, wherein the thickness of the seed layer is at most 60 Å.

Please rewrite Claim 9 as follows:

9. (Amended) An exchange coupled film according to Claim 8, wherein the seed layer has a composition represented by $(Ni_{100-x}Fe_x)$-Cr, and an atomic ratio x satisfies the relationship $0 \leq x \leq 70$.

Please rewrite Claim 14 as follows:

14. (Amended) An exchange coupled film according to Claim 1, wherein an average crystal grain size in a direction parallel to a layer surface in each layer formed on the seed layer is at least 100 Å.

Please rewrite Claim 15 as follows:

15. (Amended) An exchange coupled film according to Claim 14, wherein the average crystal grain size is at least 150 Å.

Please rewrite Claim 16 as follows:

16. (Amended) An exchange coupled film according to Claim 14, wherein the average crystal grain size is at least 170 Å.

Please rewrite Claim 17 as follows:

17. (Amended) An exchange coupled film according to Claim 1, wherein grain boundaries formed in the antiferromagnetic layer and grain boundaries formed in the ferromagnetic layer which appear in a cross section of the exchange coupled film parallel to a thickness direction are at least partially discontinuous at the interface between the antiferromagnetic layer and the ferromagnetic layer.

Please rewrite Claim 18 as follows:

18. (Amended) An exchange coupled film according to Claim 1, wherein grain boundaries formed in the antiferromagnetic layer and grain boundaries formed in the seed layer which appear in a cross section of the exchange coupled film parallel to a thickness direction are at least partially discontinuous at an interface between the antiferromagnetic layer and the seed layer.

Please rewrite Claim 23 as follows:

23. (Amended) An exchange coupled film according to Claim 22, wherein the X-Mn-X' alloy is one of an interstitial solid solution in which atoms of X' enter interstices in a space lattice comprising X and Mn and a substitutional solid solution in which atoms of X' are substituted for some atoms at lattice points of a crystal lattice comprising X and Mn.

Please rewrite Claim 24 as follows:

24. (Amended) An exchange coupled film according to Claim 21, wherein a X content is 45 to 60 atomic percent.

Please rewrite Claim 25 as follows:

25. (Amended) An exchange coupled film according to Claim 22, wherein a X + X' content is 45 to 60 atomic percent.

Please rewrite Claim 26 as follows:

26. (Amended) An exchange coupled film comprising:

a nonmagnetic or partially ferromagnetic seed layer comprising $\alpha$ and Cr, $\alpha$ being at least one of Fe, Ni, and Co;

an antiferromagnetic layer; and

a ferromagnetic layer,

the seed layer, the antiferromagnetic layer, and the ferromagnetic layer being deposited in that order from the bottom, magnetization of the ferromagnetic layer being directed in a predetermined direction by an exchange coupling magnetic field produced at an interface between the antiferromagnetic layer and the ferromagnetic layer,

wherein a Cr content of the seed layer at an interface with the antiferromagnetic layer is at least 40 atomic percent and is higher than the Cr content at another surface of the seed layer opposite to the antiferromagnetic layer, the seed layer has a region in which the Cr content gradually increases toward the antiferromagnetic layer, and a crystal structure of the seed layer at the interface with the antiferromagnetic layer is a face-centered cubic structure.

Please rewrite Claim 28 as follows:

28. (Amended) An exchange coupled film according to Claim 27, wherein the Cr content of the seed layer at the interface with the antiferromagnetic layer is 45 to 60 atomic percent.

Please rewrite Claim 30 as follows:

30. (Amended) An exchange coupled film according to Claim 29, wherein the Cr content of the seed layer at the surface opposite to the antiferromagnetic layer is 20 to 40 atomic percent.

Please rewrite Claim 32 as follows:

32. (Amended) An exchange coupled film according to Claim 31, wherein the seed layer has a composition represented by $(Ni_{100-x}Fe_x)$-Cr, and an atomic ratio x satisfies the relationship $0 \leq x \leq 70$.

Please rewrite Claim 35 as follows:

35. (Amended) An exchange coupled film according to Claim 26, wherein a thickness of the seed layer is 23 to 80 Å.

Please rewrite Claim 37 as follows:

37. (Amended) An exchange coupled film comprising:

one of a nonmagnetic and partially ferromagnetic seed layer;

an antiferromagnetic layer; and

a ferromagnetic layer,

the seed layer, the antiferromagnetic layer, and the ferromagnetic layer being deposited in that order from the bottom, magnetization of the ferromagnetic layer being directed in a predetermined direction by an exchange coupling magnetic field produced at an interface between the antiferromagnetic layer and the ferromagnetic layer,

wherein the seed layer has a layered structure comprising one of a nonmagnetic and partially ferromagnetic upper sublayer and one of a nonmagnetic and partially ferromagnetic lower sublayer, each sublayer comprising $\alpha$ and Cr, $\alpha$ being at least one of Fe, Ni, and Co,

wherein a Cr content of the upper sublayer is at least 40 atomic percent, and a crystal structure at an interface of the upper sublayer with the antiferromagnetic layer is a face-centered cubic structure,

wherein the Cr content of the upper sublayer is higher than a Cr content of the lower sublayer, and a thickness of the upper sublayer is smaller than a thickness of the lower sublayer.

Please rewrite Claim 42 as follows:

42. (Amended) An exchange coupled film according to Claim 37, wherein each of the upper sublayer and the lower sublayer comprises one of a NiFeCr alloy and a NiCr alloy.

Please rewrite Claim 43 as follows:

43. (Amended) An exchange coupled film according to Claim 37, wherein each of the upper sublayer and the lower sublayer has a composition represented by $(Ni_{100-x}Fe_x)$-Cr, and an atomic ratio x satisfies the relationship $0 \leq x \leq 70$.

Please rewrite Claim 51 as follows:

51. (Amended) An exchange coupled film according to Claim 37, wherein the seed layer further comprises at least one intermediate sublayer formed between the upper sublayer and the lower sublayer, the intermediate sublayer being one of nonmagnetic and partially ferromagnetic intermediate sublayer, the intermediate sublayer comprising $\alpha$ and Cr, $\alpha$ being at least one of Fe, Ni, and Co, and a Cr content of the intermediate sublayer is lower than the Cr content of the upper sublayer.

Please rewrite Claim 54 as follows:

54. (Amended) An exchange coupled film according to Claim 26, wherein an average crystal grain size in a direction parallel to a layer surface in each layer formed on the seed layer is at least 100 Å.

Please rewrite Claim 55 as follows:

55. (Amended) An exchange coupled film according to Claim 54, wherein the average crystal grain size is at least 150 Å.

Please rewrite Claim 56 as follows:

56. (Amended) An exchange coupled film according to Claim 26, wherein grain boundaries formed in the antiferromagnetic layer and the grain boundaries formed in the ferromagnetic layer which appear in a cross section of the exchange coupled film parallel to a thickness direction are at least partially discontinuous at the interface between the antiferromagnetic layer and the ferromagnetic layer.

Please rewrite Claim 57 as follows:

57. (Amended) An exchange coupled film according to Claim 26, wherein grain boundaries formed in the antiferromagnetic layer and grain boundaries formed in the seed layer which appear in a cross section of the exchange coupled film parallel to a thickness direction are at least partially discontinuous at the interface between the antiferromagnetic layer and the seed layer.

Please rewrite Claim 58 as follows:

58. (Amended) An exchange coupled film according to Claim 26, wherein equivalent crystal planes represented as {111} planes in the antiferromagnetic layer and the ferromagnetic layer are preferentially oriented as crystal planes parallel to the interface between the antiferromagnetic layer and the ferromagnetic layer, and at least some of equivalent crystal axes in the crystal planes are directed in different directions between the antiferromagnetic layer and the ferromagnetic layer.

Please rewrite Claim 59 as follows:

59. (Amended) An exchange coupled film according to Claim 26, wherein equivalent crystal planes represented as {111} planes in the antiferromagnetic layer and the seed layer are preferentially oriented as crystal planes parallel to the interface between the antiferromagnetic layer and the seed layer, and at least some of equivalent crystal axes in the crystal planes are directed in different directions between the antiferromagnetic layer and the seed layer.

Please rewrite Claim 62 as follows:

62. (Amended) An exchange coupled film according to Claim 61, wherein the X-Mn-X' alloy is one of an interstitial solid solution in which atoms of X' enter interstices in a space lattice comprising X and Mn and a substitutional solid solution

in which atoms of X' are substituted for some atoms at lattice points of a crystal lattice comprising X and Mn.

Please rewrite Claim 63 as follows:

63. (Amended) An exchange coupled film according to Claim 60, wherein an X content is 45 to 60 atomic percent.

Please rewrite Claim 64 as follows:

64. (Amended) An exchange coupled film according to Claim 61, wherein an X + X' content is 45 to 60 atomic percent.

Please rewrite Claim 67 as follows:

67. (Amended) An exchange coupled film according to Claim 37, wherein an average crystal grain size in a direction parallel to a layer surface in each layer formed on the seed layer is at least 100 Å.

Please rewrite Claim 68 as follows:

68. (Amended) An exchange coupled film according to Claim 67, wherein the average crystal grain size is at least 150 Å.

Please rewrite Claim 69 as follows:

69. (Amended) An exchange coupled film according to Claim 37, wherein grain boundaries formed in the antiferromagnetic layer and grain boundaries formed in the ferromagnetic layer which appear in a cross section of the exchange coupled film parallel to a thickness direction are at least partially discontinuous at the interface between the antiferromagnetic layer and the ferromagnetic layer.

Please rewrite Claim 70 as follows:

70. (Amended) An exchange coupled film according to Claim 37, wherein grain boundaries formed in the antiferromagnetic layer and grain boundaries formed in the seed layer which appear in a cross section of the exchange coupled film parallel to a thickness direction are at least partially discontinuous at the interface between the antiferromagnetic layer and the seed layer.

Please rewrite Claim 71 as follows:

71. (Amended) An exchange coupled film according to Claim 37, wherein equivalent crystal planes represented as {111} planes in the antiferromagnetic layer and the ferromagnetic layer are preferentially oriented as crystal planes parallel to the interface between the antiferromagnetic layer and the ferromagnetic layer, and at least some of equivalent crystal axes in the crystal planes are directed in different directions between the antiferromagnetic layer and the ferromagnetic layer.

Please rewrite Claim 72 as follows:

72. (Amended) An exchange coupled film according to Claim 37, wherein equivalent crystal planes represented as {111} planes in the antiferromagnetic layer and the seed layer are preferentially oriented as crystal planes parallel to the interface between the antiferromagnetic layer and the seed layer, and at least some of equivalent crystal axes in the crystal planes are directed in different directions between the antiferromagnetic layer and the seed layer.

Please rewrite Claim 75 as follows:

75. (Amended) An exchange coupled film according to Claim 74, wherein the X-Mn-X' alloy is one of an interstitial solid solution in which atoms of X' enter interstices in a space lattice comprising X and Mn and a substitutional solid solution in which atoms of X' are substituted for some atoms at lattice points of a crystal lattice comprising X and Mn.

Please rewrite Claim 76 as follows:

76. (Amended) An exchange coupled film according to Claim 73, wherein an X content is 45 to 60 atomic percent.

Please rewrite Claim 77 as follows:

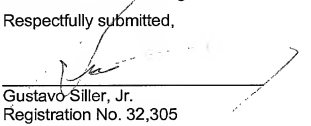
77. (Amended) An exchange coupled film according to Claim 74, wherein an X + X' content is 45 to 60 atomic percent.

**REMARKS**

Applicants have rewritten portions of the specification and Claims 1, 6, 7, 9, 14-18, 23-26, 28, 30, 32, 35, 37, 42, 43, 51, 54-59, 62-64, 67-72 and 75-77. The

changes from the previous version to the rewritten version are shown in attached Appendix A, with strikethrough for deleted matter and underlining for added matter.

Respectfully submitted,



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**APPENDIX A**
**Attorney Docket No. 9281-4288**
**Exchange Coupled Film Having Improved Current-Carrying Reliability and Improved Rate of Change in Resistance and Magnetic Sensing Element Using Same**
**Naoya Hasegawa et al.**

**In the Specification**

Please amend the paragraph on page 62, lines 4-13 as follows:

(Amended) As shown in Fig. 3, an underlayer 6, a seed layer 22, a lower antiferromagnetic layer 4, a lower pinned magnetic layer 3, a lower nonmagnetic interlayer 2, and a free magnetic layer 1 are sequentially deposited in that order. The free magnetic layer 1 is constituted of three sublayers, namely, two Co sublayers 10 and a NiFe alloy sublayer 9. On the free magnetic layer 1, an upper nonmagnetic interlayer 52, an upper pinned magnetic layer 53, and an upper antiferromagnetic layer 54, and a protective layer 7 are sequentially deposited. The upper pinned magnetic layer 53 contains layers similar to that of the lower pinned magnetic layer 13. That is: an upper first magnetic sublayer 111, similar in composition and thickness to the first magnetic sublayer 11, an upper intermediate sublayer 112, similar in composition and thickness to the intermediate magnetic sublayer 12, and an upper second magnetic sublayer 113, similar in composition and thickness to the second magnetic sublayer 13.

Please amend the paragraph on page 125, lines 12-21 as follows:

(Amended) As shown in Fig. 22, an underlayer 6, a seed layer 22, a lower antiferromagnetic layer 4, a lower pinned magnetic layer 3, a lower nonmagnetic interlayer 2, and a free magnetic layer 1 are sequentially deposited in that order. The free magnetic layer 1 is constituted of three sublayers, namely, two Co sublayers 10 and a NiFe alloy sublayer 9. On the free magnetic layer 1, an upper nonmagnetic interlayer 52, an upper pinned magnetic layer 53, and an upper antiferromagnetic layer 54, and a protective layer 7 are sequentially deposited. The upper pinned magnetic layer 53 has similar layers as that of the upper magnetic layer shown in Fig. 3.

**In the Claims**

Please amend Claim 1 as follows:

1. (Amended) An exchange coupled film comprising:

a nonmagnetic seed layer comprising $\alpha$ and Cr, $\alpha$ being at least one of Fe, Ni, and Co;

an antiferromagnetic layer; and

a ferromagnetic layer,

the seed layer, the antiferromagnetic layer, and the ferromagnetic layer being deposited in that order from the bottom, ~~the~~ magnetization of the ferromagnetic layer being directed in a predetermined direction by an exchange coupling magnetic field produced at ~~the~~an interface between the antiferromagnetic layer and the ferromagnetic layer,

wherein ~~the~~a Cr content of the seed layer is 35 to 60 atomic percent, ~~the~~a thickness of the seed layer is 10 to 200 Å, and ~~the~~a crystal structure of the seed layer is a face-centered cubic structure.

Please amend Claim 6 as follows:

6. (Amended) An exchange coupled film according to Claim 1, wherein the thickness of the seed layer is at most 80 Å ~~or less~~.

Please amend Claim 7 as follows:

7. (Amended) An exchange coupled film according to Claim 1, wherein the thickness of the seed layer is at most 60 Å ~~or less~~.

Please amend Claim 9 as follows:

9. (Amended) An exchange coupled film according to Claim 8, wherein the seed layer has a composition represented by $(Ni_{100-x}Fe_x)$-Cr, and ~~the~~an atomic ratio x satisfies the relationship $0 \leq x \leq 70$.

Please amend Claim 14 as follows:

14. (Amended) An exchange coupled film according to Claim 1, wherein ~~the~~an average crystal grain size in a direction parallel to ~~the~~a layer surface in each layer formed on the seed layer is at least 100 Å ~~or more~~.

Please amend Claim 15 as follows:

15. (Amended) An exchange coupled film according to Claim 14, wherein the average crystal grain size is at least 150 Å ~~or more~~.

Please amend Claim 16 as follows:

16. (Amended) An exchange coupled film according to Claim 14, wherein the average crystal grain size is at least 170 Å ~~or more~~.

Please amend Claim 17 as follows:

17. (Amended) An exchange coupled film according to Claim 1, wherein ~~the~~ grain boundaries formed in the antiferromagnetic layer and ~~the~~ grain boundaries formed in the ferromagnetic layer which appear in a cross section of the exchange coupled film parallel to ~~the~~a thickness direction are at least partially discontinuous at the interface between the antiferromagnetic layer and the ferromagnetic layer.

Please amend Claim 18 as follows:

18. (Amended) An exchange coupled film according to Claim 1, wherein ~~the~~ grain boundaries formed in the antiferromagnetic layer and ~~the~~ grain boundaries formed in the seed layer which appear in a cross section of the exchange coupled film parallel to ~~the~~a thickness direction are at least partially discontinuous at ~~the~~an interface between the antiferromagnetic layer and the seed layer.

Please amend Claim 23 as follows:

23. (Amended) An exchange coupled film according to Claim 22, wherein the X-Mn-X' alloy is ~~either~~one of an interstitial solid solution in which atoms of X' enter interstices in a space lattice comprising X and Mn ~~or~~and a substitutional solid solution in which atoms of X' are substituted for some atoms at ~~the~~ lattice points of a crystal lattice comprising X and Mn.

Please amend Claim 24 as follows:

24. (Amended) An exchange coupled film according to Claim 21, wherein ~~the~~a X content is 45 to 60 atomic percent.

Please amend Claim 25 as follows:

25. (Amended) An exchange coupled film according to Claim 22, wherein ~~the~~a X + X' content is 45 to 60 atomic percent.

Please amend Claim 26 as follows:

26. (Amended) An exchange coupled film comprising:

a nonmagnetic or partially ferromagnetic seed layer comprising $\alpha$ and Cr, $\alpha$ being at least one of Fe, Ni, and Co;

an antiferromagnetic layer; and

a ferromagnetic layer,

the seed layer, the antiferromagnetic layer, and the ferromagnetic layer being deposited in that order from the bottom, ~~the~~ magnetization of the ferromagnetic layer being directed in a predetermined direction by an exchange coupling magnetic field produced at ~~the~~an interface between the antiferromagnetic layer and the ferromagnetic layer,

wherein ~~the~~a Cr content of the seed layer at ~~the~~an interface with the antiferromagnetic layer is at least 40 atomic percent ~~or more~~ and is higher than the Cr content at another surface of the seed layer opposite to the antiferromagnetic layer, the seed layer has a region in which the Cr content gradually increases toward the antiferromagnetic layer, and ~~the~~a crystal structure of the seed layer at the interface with the antiferromagnetic layer is a face-centered cubic structure.

Please amend Claim 28 as follows:

28. (Amended) An exchange coupled film according to Claim 27, wherein the Cr content of the seed layer at the interface with the antiferromagnetic layer is 45 to 60 atomic percent.

Please amend Claim 30 as follows:

30. (Amended) An exchange coupled film according to Claim 29, wherein the Cr content of the seed layer at the surface opposite to the antiferromagnetic layer is 20 to 40 atomic percent.

Please amend Claim 32 as follows:

32. (Amended) An exchange coupled film according to Claim 31, wherein the seed layer has a composition represented by $(Ni_{100-x}Fe_x)$-Cr, and ~~the~~an atomic ratio x satisfies the relationship $0 \leq x \leq 70$.

Please amend Claim 35 as follows:

35. (Amended) An exchange coupled film according to Claim 26, wherein ~~the~~a thickness of the seed layer is 23 to 80 Å.

Please amend Claim 37 as follows:

37. (Amended) An exchange coupled film comprising:

one of a nonmagnetic ~~e~~rand partially ferromagnetic seed layer;

an antiferromagnetic layer; and

a ferromagnetic layer,

the seed layer, the antiferromagnetic layer, and the ferromagnetic layer being deposited in that order from the bottom, ~~the~~ magnetization of the ferromagnetic layer being directed in a predetermined direction by an exchange coupling magnetic field produced at ~~the~~an interface between the antiferromagnetic layer and the ferromagnetic layer,

wherein the seed layer has a layered structure comprising one of a nonmagnetic ~~e~~rand partially ferromagnetic upper sublayer and one of a nonmagnetic ~~e~~rand partially ferromagnetic lower sublayer, each sublayer comprising $\alpha$ and Cr, $\alpha$ being at least one of Fe, Ni, and Co,

wherein ~~the~~a Cr content of the upper sublayer is at least 40 atomic percent ~~or more~~, and ~~the~~a crystal structure at ~~the~~an interface of the upper sublayer with the antiferromagnetic layer is a face-centered cubic structure,

wherein the Cr content of the upper sublayer is higher than ~~the~~a Cr content of the lower sublayer, and ~~the~~a thickness of the upper sublayer is smaller than ~~the~~a thickness of the lower sublayer.

Please amend Claim 42 as follows:

42. (Amended) An exchange coupled film according to Claim 37, wherein each of the upper sublayer and the lower sublayer comprises one of a NiFeCr alloy ~~e~~rand a NiCr alloy.

Please amend Claim 43 as follows:

43. (Amended) An exchange coupled film according to Claim 37, wherein each of the upper sublayer and the lower sublayer has a composition represented by $(Ni_{100-x}Fe_x)$-Cr, and ~~the~~an atomic ratio x satisfies the relationship $0 \leq x \leq 70$.

Please amend Claim 51 as follows:

51. (Amended) An exchange coupled film according to Claim 37, wherein the seed layer further comprises at least one intermediate sublayer formed between the upper sublayer and the lower sublayer, the intermediate sublayer being one of nonmagnetic ~~or~~and partially ferromagnetic intermediate sublayer ~~formed between the upper sublayer and the lower sublayer~~, the intermediate sublayer comprising $\alpha$ and Cr, $\alpha$ being at least one of Fe, Ni, and Co, and ~~the~~a Cr content of the intermediate sublayer is lower than the Cr content of the upper sublayer.

Please amend Claim 54 as follows:

54. (Amended) An exchange coupled film according to Claim 26, wherein ~~the~~an average crystal grain size in a direction parallel to ~~the~~a layer surface in each layer formed on the seed layer is at least 100 Å ~~or more~~.

Please amend Claim 55 as follows:

55. (Amended) An exchange coupled film according to Claim 54, wherein the average crystal grain size is at least 150 Å ~~or more~~.

Please amend Claim 56 as follows:

56. (Amended) An exchange coupled film according to Claim 26, wherein ~~the~~ grain boundaries formed in the antiferromagnetic layer and the grain boundaries formed in the ferromagnetic layer which appear in a cross section of the exchange coupled film parallel to ~~the~~a thickness direction are at least partially discontinuous at the interface between the antiferromagnetic layer and the ferromagnetic layer.

Please amend Claim 57 as follows:

57. (Amended) An exchange coupled film according to Claim 26, wherein ~~the~~ grain boundaries formed in the antiferromagnetic layer and ~~the~~ grain boundaries formed in the seed layer which appear in a cross section of the exchange coupled

film parallel to ~~the~~a thickness direction are at least partially discontinuous at the interface between the antiferromagnetic layer and the seed layer.

Please amend Claim 58 as follows:

58. (Amended) An exchange coupled film according to Claim 26, wherein equivalent crystal planes represented as {111} planes in the antiferromagnetic layer and the ferromagnetic layer are preferentially oriented as crystal planes parallel to the interface between the antiferromagnetic layer and the ferromagnetic layer, and at least some of ~~the~~ equivalent crystal axes in the crystal planes are directed in different directions between the antiferromagnetic layer and the ferromagnetic layer.

Please amend Claim 59 as follows:

59. (Amended) An exchange coupled film according to Claim 26, wherein equivalent crystal planes represented as {111} planes in the antiferromagnetic layer and the seed layer are preferentially oriented as crystal planes parallel to the interface between the antiferromagnetic layer and the seed layer, and at least some of ~~the~~ equivalent crystal axes in the crystal planes are directed in different directions between the antiferromagnetic layer and the seed layer.

Please amend Claim 62 as follows:

62. (Amended) An exchange coupled film according to Claim 61, wherein the X-Mn-X' alloy is ~~either~~one of an interstitial solid solution in which atoms of X' enter interstices in a space lattice comprising X and Mn ~~or~~and a substitutional solid solution in which atoms of X' are substituted for some atoms at ~~the~~ lattice points of a crystal lattice comprising X and Mn.

Please amend Claim 63 as follows:

63. (Amended) An exchange coupled film according to Claim 60, wherein ~~the~~an X content is 45 to 60 atomic percent.

Please amend Claim 64 as follows:

64. (Amended) An exchange coupled film according to Claim 61, wherein ~~the~~an X + X' content is 45 to 60 atomic percent.

Please amend Claim 67 as follows:

67. (Amended) An exchange coupled film according to Claim 37, wherein ~~the~~an average crystal grain size in a direction parallel to ~~the~~a layer surface in each layer formed on the seed layer is at least 100 Å ~~or more~~.

Please amend Claim 68 as follows:

68. (Amended) An exchange coupled film according to Claim 67, wherein the average crystal grain size is at least 150 Å ~~or more~~.

Please amend Claim 69 as follows:

69. (Amended) An exchange coupled film according to Claim 37, wherein ~~the~~ grain boundaries formed in the antiferromagnetic layer and ~~the~~ grain boundaries formed in the ferromagnetic layer which appear in a cross section of the exchange coupled film parallel to ~~the~~a thickness direction are at least partially discontinuous at the interface between the antiferromagnetic layer and the ferromagnetic layer.

Please amend Claim 70 as follows:

70. (Amended) An exchange coupled film according to Claim 37, wherein ~~the~~ grain boundaries formed in the antiferromagnetic layer and ~~the~~ grain boundaries formed in the seed layer which appear in a cross section of the exchange coupled film parallel to ~~the~~a thickness direction are at least partially discontinuous at the interface between the antiferromagnetic layer and the seed layer.

Please amend Claim 71 as follows:

71. (Amended) An exchange coupled film according to Claim 37, wherein equivalent crystal planes represented as {111} planes in the antiferromagnetic layer and the ferromagnetic layer are preferentially oriented as crystal planes parallel to the interface between the antiferromagnetic layer and the ferromagnetic layer, and at least some of ~~the~~ equivalent crystal axes in the crystal planes are directed in different directions between the antiferromagnetic layer and the ferromagnetic layer.

Please amend Claim 72 as follows:

72. (Amended) An exchange coupled film according to Claim 37, wherein equivalent crystal planes represented as {111} planes in the antiferromagnetic layer and the seed layer are preferentially oriented as crystal planes parallel to the interface between the antiferromagnetic layer and the seed layer, and at least some

of ~~the~~ equivalent crystal axes in the crystal planes are directed in different directions between the antiferromagnetic layer and the seed layer.

Please amend Claim 75 as follows:

75. (Amended) An exchange coupled film according to Claim 74, wherein the X-Mn-X' alloy is ~~either~~one of an interstitial solid solution in which atoms of X' enter interstices in a space lattice comprising X and Mn ~~or~~and a substitutional solid solution in which atoms of X' are substituted for some atoms at ~~the~~ lattice points of a crystal lattice comprising X and Mn.

Please amend Claim 76 as follows:

76. (Amended) An exchange coupled film according to Claim 73, wherein ~~the~~an X content is 45 to 60 atomic percent.

Please amend Claim 77 as follows:

77. (Amended) An exchange coupled film according to Claim 74, wherein ~~the~~an X + X' content is 45 to 60 atomic percent.